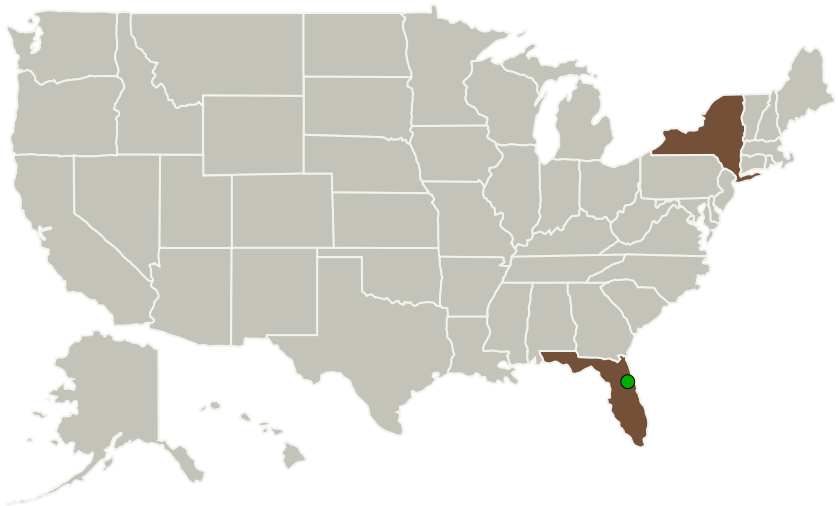
The World is Not Enough (WINE): Harvesting Local Resources for Eternal Exploration of Space, Phase II

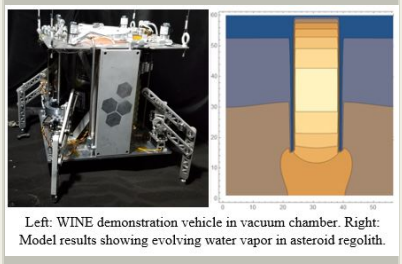
Completed Technology Project (2016 - 2018)

Project Introduction

The World is Not Enough (WINE) is a new generation of CubeSats that take advantage of ISRU to explore space. The WINE takes advantage of existing CubeSat technology and combines it with 3D printing technology and an In Situ Resource utilization (ISRU) water extraction system. 3D printing enables development of steam thrusters (higher Isp than cold gas) as well as tanks that fit within the available space within the CubeSat. The ISRU module captures and extracts water, and takes advantage of the heat generated by the CubeSat electronics system with supplemental power from solar charged batteries. The water is stored in a steam thruster tank and used for propulsion. Thus, the system can use the water that it has just extracted as fuel to fly to another location. The WINE is ideally suited as a prospecting mission and reconnaissance mission before the mining/exploration missions are launched. In Phase 1, we demonstrated critical technologies such as (1) sample acquisition, (2) volatiles capture, and (3) various CubeSat designs. In Phase 2, we propose to develop a testbed of the critical ISRU/propulsion system (regolith -> volatiles -> tank -> thruster) and GNC technology, and in Phase 3 we will demonstrate it in space as a hitchhiker payload on a mission such as EM-1 or EM-2, or onboard the International Space Station (ISS). An ISS demonstration can extract water from a meteorite analog (brought up to ISS), use the water to fuel a WINE CubeSat, eject it into LEO, and measure propulsion performance to improve the technology as it demonstrates a change in Delta-V from asteroid-mined water. The main objective of this effort is to develop a WINE spacecraft with capability to prospect planetary bodies using its instruments, perform ISRU to extract volatiles (water), and use water in a thermal steam propulsion system to keep exploring the Solar System.

Primary U.S. Work Locations and Key Partners





Left: WINE demonstration vehicle in vacuum chamber. Right: Model results showing evolving water vapor in asteroid regolith.

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Organizations Performing Work	Role	Type	Location
Honeybee Robotics, Ltd.	Lead Organization	Industry	Pasadena, California
Kennedy Space Center(KSC)	Supporting Organization	NASA Center	Kennedy Space Center, Florida
University of Central Florida(UCF)	Supporting Organization	Academia Hispanic Serving Institutions (HSI)	Orlando, Florida

Primary U.S. Work Locations	
Florida	New York

Project Transitions

September 2016: Project Start

December 2018: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/138581)*

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Honeybee Robotics, Ltd.

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

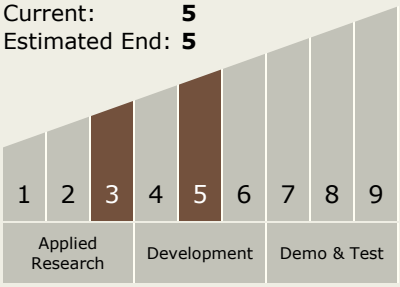
Carlos Torrez

Principal Investigator:

Philip T Metzger

Technology Maturity (TRL)

Start: **3**
Current: **5**
Estimated End: **5**



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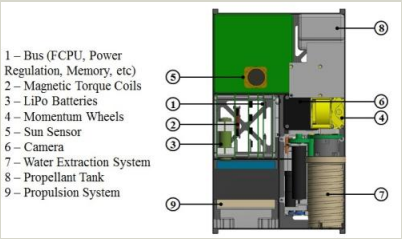
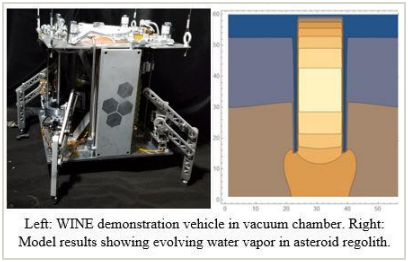
Images



Briefing Chart Image
The World is Not Enough (WINE): Harvesting Local Resources for Eternal Exploration of Space, Phase II
(https://techport.nasa.gov/image/128600)


Left: WINE demonstration vehicle in vacuum chamber. Right: Model results showing evolving water vapor in asteroid regolith.

Final Summary Chart Image
The World is Not Enough (WINE): Harvesting Local Resources for Eternal Exploration of Space, Phase II
(https://techport.nasa.gov/image/134037)

Technology Areas

Primary:

- TX07 Exploration Destination Systems
  - TX07.1 In-Situ Resource Utilization
    - TX07.1.1 Destination Reconnaissance and Resource Assessment

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System